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Digital Transitions for the Use and Reuse of Digital Assets for Museum Collections

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Abstract

Nowadays, digital assets have become increasingly important for heritage institutions and individuals. Digital assets, such as images, videos, audio files, text, and 3D models, are used in various contexts, including cultural heritage, for diverse purposes. Museums offered free access to their collections during the COVID emergency, enlightening the necessity of using and reusing these assets efficiently and effectively. In the museum sector, diverse content must be created for different target audiences using various narrative styles and digital storytelling.
The paper addresses the diverse use of the same digital asset consisting of a small wooden *maquettes* collection. The heterogeneous historical data and information collected about maquettes generates a comprehensive digital asset allowing the creation of many outcomes for both researchers and the large public, including maps, virtual reality experiences, and information systems to access documentary and archival heritage.
The digitization process of all contents involves different approaches to encoding metadata about the steps and methods of digitization – *provenance* and *processes* – for both digital representations of 1D, 2D, 3D resources and virtual environments.
The paper shows the different methodological approaches used for disseminating digitalized content collected during a funded project and the definition of various outcomes according to the diverse targeted audience.

Keywords
Museum Collections, Web-based applications, Virtual Reality, uMap, ResearchSpace



Mozilla Hubs interface of a digital exhibition made reusing 3D digital asset. Digital environment developed by the author.

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Digital Assets and their reuse

In 2016, the *FAIR Guiding Principles for scientific data management and stewardship* [1] were published in Scientific Data. The principles emphasize machine-readable practice in data management systems as their capacity to find, access, interoperate, and reuse data with no or minimal human intervention. The authors intended to provide guidelines to improve the Findability, Accessibility, Interoperability, and Reuse of digital assets.
Despite the general belief that data regards the scientific sector, it is possible to assume that data are primary resources also within the Cultural Heritage domain.
Digital Cultural Heritage assets are used mainly in various contexts and with previously unimaginable file formats. In education, they can create interactive and engaging learning experiences. In entertainment, they can be used to make films, 3D animations, and video games. Images, videos, and audio files are also used to create engagement and compelling content for dissemination in cultural heritage projects.
Reusing digital assets has become an essential aspect of digital asset management: the ability to reuse digital assets enhances the productivity and creativity of cultural institutions by allowing them to save time and resources. Depending on the data acquired, there is *a priori* concern about the type of output to be obtained in cultural heritage digitization projects. Depending on the dissemination or scientific purpose, an attempt is to identify the most suitable platform or tool.
This happens not only for 3D models but also for all the iconographic and documentary material that usually characterizes research in cultural heritage.. Documentary and archival resources follow the rules peculiar to the disciplinary field to which they pertain but pose different considerations in the field of architectural drawings and digital representations. This study presents a methodological workflow for creating a digital asset composed of 3D models and archival and historical resources. [Giovannini et al. 2019; Mafrici, Giovannini 2020]. The digital asset (fig. 1)also contains many drawings and architectural representations of diverse types: sketches, survey drawings, and layout tables called *planches*, for the printed edition of the Jean-Jacques Rifaud oeuvre "*Voyage en Égypte, en Nubie, et lieux circumvoisins*" [2].

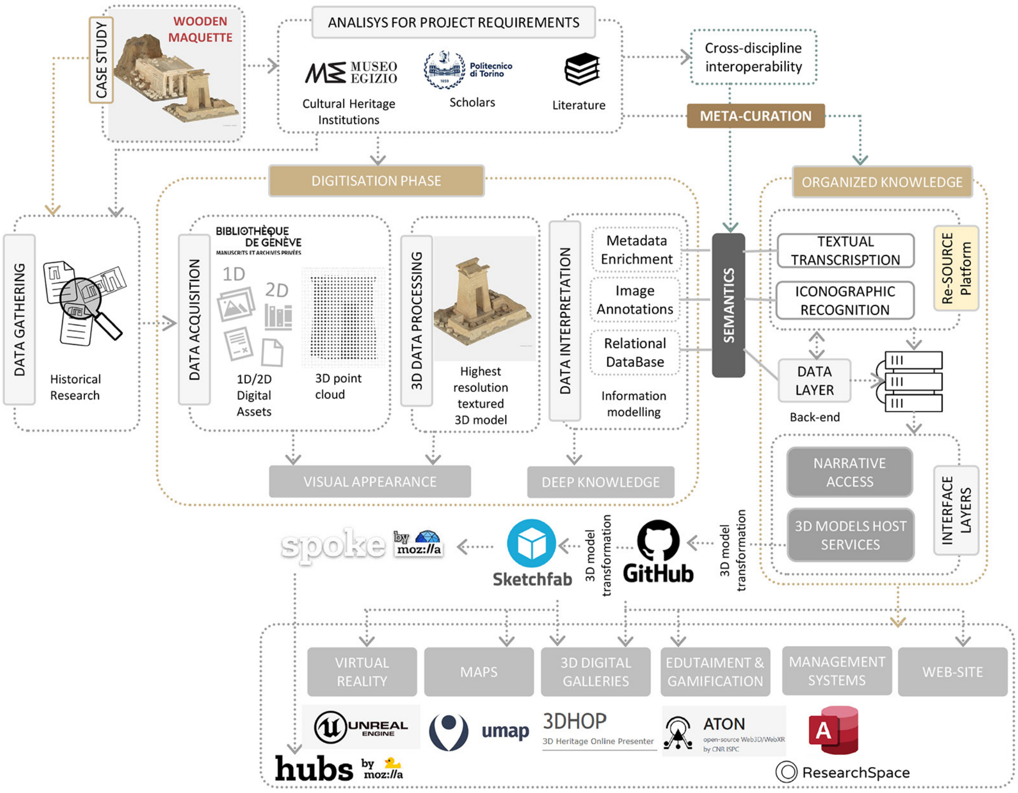


Fig. 1. Methodological workflow for the definition of the digital asset developed during the project [2], to create diverse digital cultural content using various platforms for 3D models, SketchFab [3], 3DHop [4] by ISTI-CNR, ATON [5] by ISPC-CNR. The VR was created using both Unreal Engine and Spoke by Mozilla Hubs [6]. The 1D and 2D assets were stored in a Microsoft Access DB for remote access and online using ResearchSpace Knowledge System Platform [7]. Image by the author.

Rifaud documented his trip in Egypt on his never finished oeuvre, which should have been composed of 300 *planches*. Some *planches* are relevant to the research as they represented the temples depicted by maquettes conserved at Egyptian Museum in Turin, a project's partner.

2D digital assets: digitization and metadata encoding with a semantic approach

Digitization of cultural heritage refers to converting physical artifacts, documents, and other cultural materials into digital formats that can be stored, preserved, and shared electronically. This process allows for greater access to cultural heritage materials and makes preservation efforts more efficient. In addition, digitization can facilitate research, education, and interpretation and provide new opportunities for public engagement with cultural heritage.
Digital Asset Management (D.A.M.) organizes, stores, and retrieves digital assets. The system can help organizations and individuals to effectively use and reuse digital assets by providing tools for managing, searching, and retrieving assets. The role of D.A.M. in libraries and archives, together with the Collection Management Systems (C.M.S.) in museums, is a well-established practice. The ICT sector offers, for long time, a series of services and suitable solutions to manage diverse type of data, also using recognized standards for both digital libraries and archives. The same happens in the museum sector, where, for example, Europeana [8] initiatives offer a panorama of structured and standardized digitization workflows. Europeana and other recently funded European projects nowadays have conservation or restoration purposes and dissemination objectives.
Following this purpose, the project – to which the digital assets belong – used a digital environment developed by the museum community for research: the ResearchSpace [9] knowledge graph system can store and analyze diverse digitalized content. The resources were organized and collected using as primary reference the temple depicted by each source: drawings, survey drawings, *planches*, and *maquettes*. The content was analyzed using image annotations adding semantic layers related to architectural elements, their diverse visualization types and architectural representations [Giovannini 2021].
The resources used were partially digitalized by the professionals of the *Manuscrits et Archives* area of the *Bibliothèque de Genève (BGE)*: original drawings by Rifaud. Other iconographical material, *planches*, were digitalized from the more recent scientific publication about the oeuvre of Rifaud [Bruwier et al. 2014; Claes 2014].
All material acquired with the highest resolution was resampled and exported in a different file format (.jpg). Image files have been decreased in quality between 25 % and 50% to be accessible through the web (fig. 2).
Creating an organized digital asset in ResearchSpace, allowed to link textual descriptions with original drawings and *planches* they describe. The manuscripts conserved at the BGE offered a detailed description of the drawings. Then, the 1D textual dimension was connected to a 2D asset composed of drawings and planches, and finally, with the 3D content: the digital photogrammetric model of the museum collection (fig. 3).
The 2D digital asset was also used to develop a prototype for a 3D web-based puzzle made in collaboration with ISPC-CNR [Lo Turco et al. 2019].
The proposed solution pertains to the context of gamification and edutainment in the cultural heritage sector. At the end of the game, it is possible to access the 3D model of the temple of Tafa Sud resulting from the digital photogrammetric acquisition and hosted by an online repository in GitHub (fig. 4).

3D digital assets: digitization and visualization tools

The project's interdisciplinary nature implied a split between the metric acquisition of the *maquettes*, performed by a geomatic team [Spreafico et al. 2020], and the preparation of the resulting 'raw' data for use through open and web-based systems.

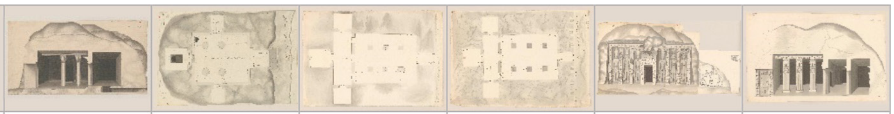
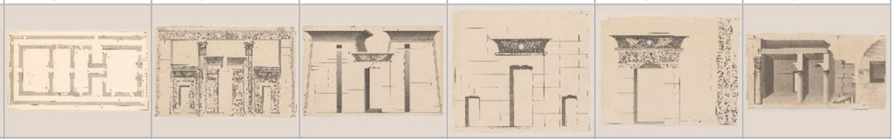
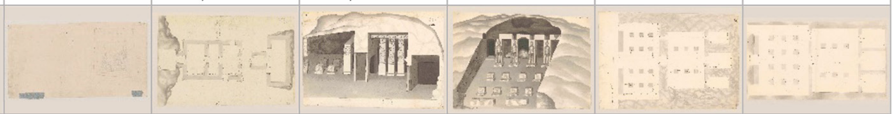
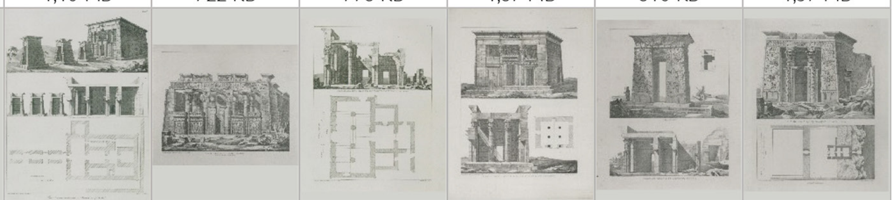
Manuscripts & Archives - BGE Ms-fr_1602						
resolution (px)	7160 x 4025	5403 x 3768	6337 x 4534	6337 x 4534	11745 x 6108	8410 x 5431
original (.tif)	87,2 MB	58,5 MB	82,5 MB	82,5 MB	205 MB	131 MB
RS/uMAP (.jpg)	2,40 MB	1,80 MB	853 KB	939 KB	1,83 MB	1,66 MB
Manuscripts & Archives - BGE *Ms-fr_1602*						
resolution (px)	6080 x 3468	5746 x 3788	7042 x 4582	3747 x 3370	4667 x 3718	5899 x 3266
original (.tif)	45,2 MB	62,5 MB	92,6 MB	36,4 MB	35,3 MB	55,4 MB
RS/uMAP (.jpg)	962 KB	1,43 MB	1,32 MB	664 KB	977 KB	980 KB
Manuscripts & Archives - BGE *Ms-fr_1602*						
resolution (px)	5899 x 3266	5579 x 3677	8504 x 5814	6310 x 4617	5780 x 4151	8455 x 5034
original (.tif)	55,4 MB	41,2 MB	141 MB	83,6 MB	68,9 MB	82,1 MB
RS/uMAP (.jpg)	789 KB	929 KB	1,32 MB	842 KB	669 KB	912 KB
Manuscripts & Archives - BGE *Ms-fr_1602*						
resolution (px)	6378 x 5710	6044 x 4311	6178 x 4450	6178 x 4763	5969 x 4317	13855 x 5014
original (.tif)	104 MB	74,8 MB	78,9 MB	84,5 MB	52,4 MB	199 MB
RS/uMAP (.jpg)	1,10 MB	722 KB	778 KB	1,87 MB	810 KB	1,57 MB
Plances from Claes, W. (2014) *Les lithographies de Jean-Jacques Rifaud.*						
resolution (px)	4571 x 6007	5202 x 4279	5163 x 6181	5146 x 6821	5148 x 6082	5166 x 6183
original (.tif)	152 MB	63,7 MB	91,3 MB	100 MB	89,6 MB	91,4 MB
RS/uMAP (.jpg)	1,80 MB	1,69 MB	1,75 MB	2,06 MB	2,17 MB	2,33 MB
Plances from Claes, W. (2014) *Les lithographies de Jean-Jacques Rifaud.*						
resolution (px)	5196 x 4289	5167 x 4238	5161 x 6189	5145 x 6166	5174 x 4294	5189 x 3872
original (.tif)	63,7 MB	62,6 MB	91,4 MB	90,7 MB	63,5 MB	57,5 MB
RS/uMAP (.jpg)	1,49 MB	1,45 MB	2,36 MB	2,25 MB	1,52 MB	784 KB
Plances from Claes, W. (2014) *Les lithographies de Jean-Jacques Rifaud.*						
resolution (px)	5172 x 3879	5189 x 4288	5129 x 4266	5180 x 4301	5180 x 6177	5196 x 4315
original (.tif)	57,4 MB	63,6 MB	62,6 MB	63,7 MB	180 MB	126 MB
RS/uMAP (.jpg)	1,06 MB	1,31 MB	1,23 MB	1,32 MB	2,44 MB	1,53 MB

Fig. 2. The image collects information about primary resource and secondary resources obtained by reducing quality of images to be hosted by ResearchSpace (RS) and uMAP. A table with pictures of drawings from BGE, acquired at 600dpi with a i2S SupraScan II and planches from Claes (2014) acquired at 600dpi. Image by the author.

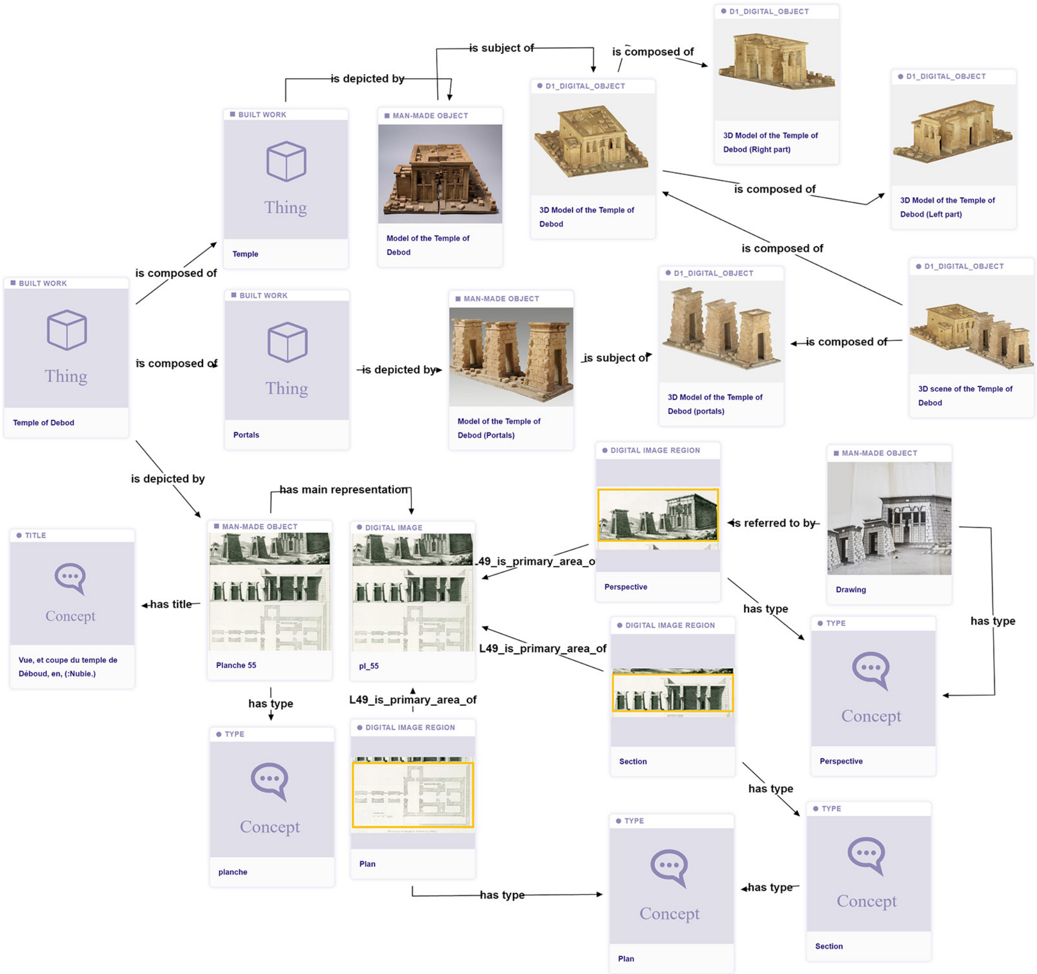


Fig. 3. ResearchSpace knowledge map that collect 1D, 2D and 3D content available. Image by the author.

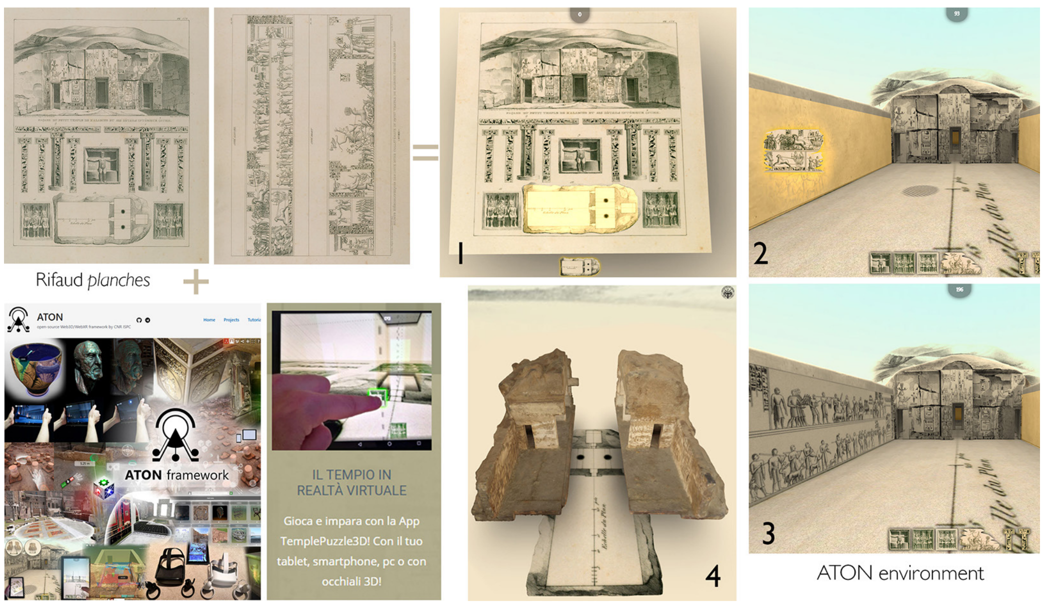


Fig. 4. Workflow to create the puzzle 3D web app developed by Bruno Fanini at ISPC-CNR, <http://seth.itabc.cnr.it:8082/>. The final step of the Puzzle 3D introduces the 3D model available on the GitHub repository created by the author using 3DHop hosting the 3D of the Temple of Tafa South. Image by the author.

The *maquettes* have the peculiarity of being divided into two parts. It is possible to open them and discover their internal sections. To complete some 3D scenes was necessary to add a second model that generally represents the monumental entrance path to the temple: Portals or Propyleia [Giovannini, Tomalini 2020]. The post-processing phase involved MeshLab [10] to organize the 3D models in diverse scenes to be displayed using 3DHop. 3DHop is designed as a scientific tool capable of precisely visualizing high-resolution textured models. Before being uploaded to the repository, the models were retopologized using the Quadric Edge Collapse Decimation (with texture) filter [Garland, Heckbert 1998]. A GitHub repository [11] hosts the digital asset for 3D models. The prototype phase concerned the development of a series of .html web pages for each maquette. The basic .html code was implemented by configuring a user interface that allows, for example, to turn off and on the parts of which the model is composed, making the visualization more complete [Potenziani et al. 2015; Potenziani et al. 2018]. However, Web-design requires considerable effort and advanced knowledge of CSS code. Therefore, the SketchFab platform for online visualization of 3D content was chosen for larger-scale dissemination. The platform, unlike 3DHop, is partially free. Another substantial difference between the two solutions is the inability of SketchFab to display parts individually, turning them on and off. An external solution has recently been developed to separate visualization of the components that make up the scene [12]. The possibility that SketchFab offers to embed content into any html application is a powerful solution; however, it is limited in its ability to display models no larger than 200MB, including textures files. The use and reuse of the 3D asset needed the 3D to be edited at various times according to the platform's requirements to host them (fig. 5).



Fig. 5. Diverse user interfaces of the digital galleries developed using diverse 3D assets. The content can be also accessed by using QR codes to reach different online URL addresses. Image by the author.

Mapping narratives using uMAP

The project's dissemination content included using maps as a narrative vehicle. This approach fits within research topics such as 'story maps,' 'fictional cartography', 'narrative atlas,' and 'geospatial storytelling', which characterize the growing interest in the relationship between maps and narratives [Caquard 2011].
The map has storytelling purposes. The narrative style aims to create an approach to interpret and map the travel diaries of J.J. Rifaud: the proposed content presents texts from his travel diary, the maquettes probably made by local craftsmen, original sketches, survey drawings, and the published planches.
Among the information classified during the project, care was taken to investigate the geolocalization of temples that were retrieved from online archeological repositories.
The data obtained were then used to create an interactive map showing the temple location by associating it with the previously developed 1D, 2D, and 3D materials. The map was first prototyped using Thinglink and then developed using uMAP [13]. Thinglink is a platform for creating interactive media using images, videos, virtual tours, 3D models, and simulations. uMAP provides an open-source and easy-to-use graphical interface for customizing maps and geolocating datasets specially created or retrieved from Open Data repositories. uMAP enables the creation of maps that use OpenStreetMap layers as background [Shahamati et al. 2022]. In the prototype phase, a map drawn by J. J. Rifaud was used as background for the interactive map (fig. 6).
In both maps, places are indicated with customizable markers. In uMAP, the place information within a descriptive field can be implemented by adding any content embedded with a specific URL reference. The resource, image, video, or 3D model must be hosted by an online repository to be retrievable (fig. 7).

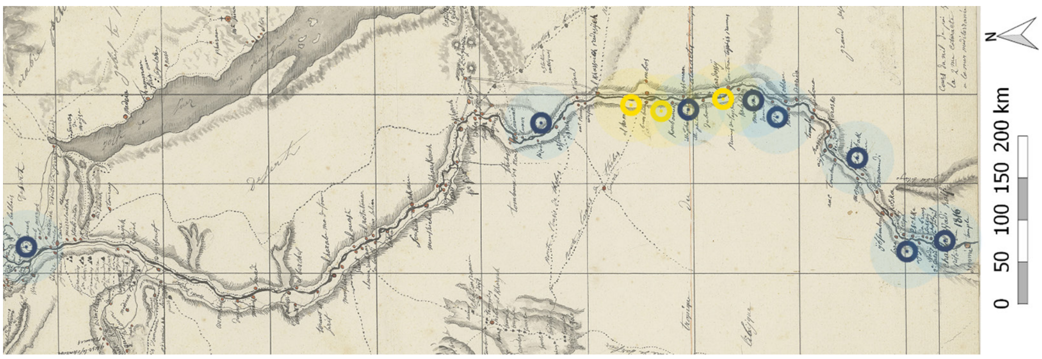


Fig. 6. Prototype of the map, developed by Ph.D., Noemi Mafrici, with hotspots in the Temples positions. The hotspots allow access to the 3D model hosted by the GitHub repository.

Digital storytelling using Virtual Reality

The use of virtual reality in recent years has witnessed a growth of interest on the part of museum institutions. One approach to creating virtual museums that are copies of real ones consists of using 360° acquisition technology to capture the museum environment. The virtual tours can be implemented in the scene with additional information layers. This solution was chosen by diverse museums that want to make their collections accessible. Museums that developed this type of virtual tour are The Metropolitan Museum of Art [14], Guggenheim Museum [15], Louvre Museum [16], The Uffizi Gallery [17] and many others around the world. A more complex type of product is the virtual museum, which involves a digital environment to be designed and modeled (container) and content: the museum collection to be organized within the built space. Another choice in creating a container 3D modeling is to replicate an existing space: an example is the Modigliani VR [18]. An additional narrative suggestion that goes in this direction came from analyzing archival sources at the museum: a drawing representing a floor plan, undated but showing an inventoried exhibition layout:

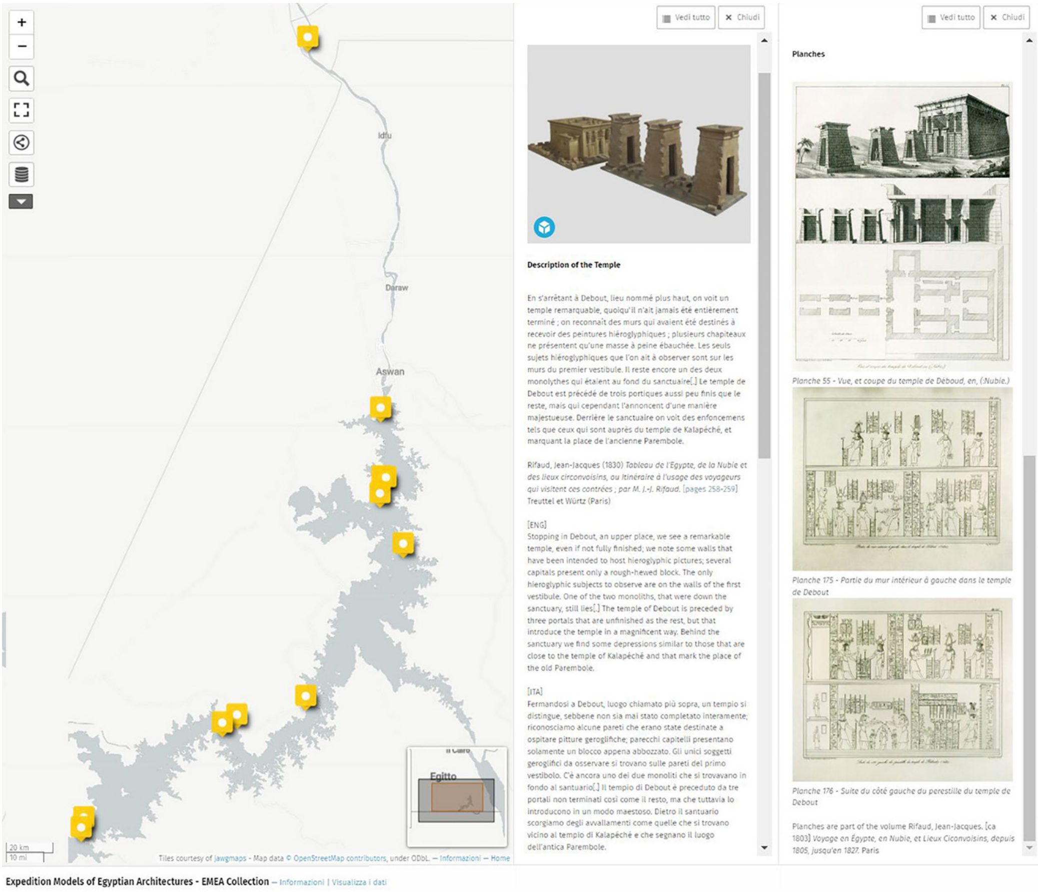


Fig. 7. The uMAP developed for the *Expedition Models of Egyptian Architecture - EMEA Collection* - Temple of Debod.

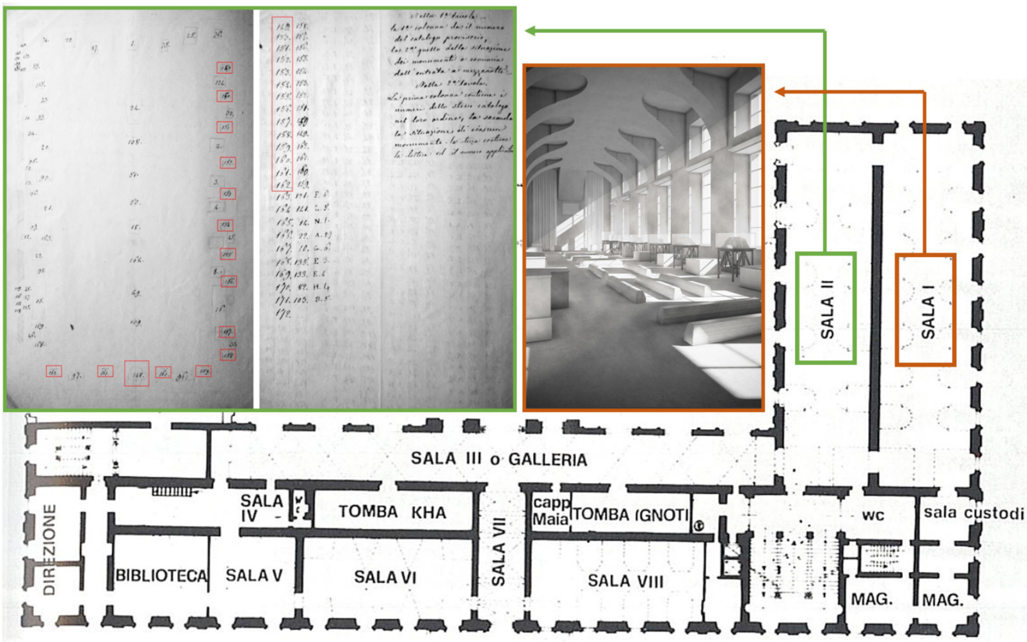


Fig. 8. Archival and historical documentation used to create the Virtual Reality (VR) scene.



Fig. 9. Comparison between Photographic documentation conserved at the Museo Egizio (top) 3D model (bottom-left) and Unreal Engine user interface developed by Enrico Picchio (bottom-right). Image by the author.

a list of inventory numbers that mention the *maquettes* follows the sketch. Both documents were analyzed to recreate the exhibition layout using virtual environments. The information was then interpolated with historical photos representing the layout exhibition but in a different hall (figs. 8, 9).
The Unreal Engine was chosen as the fruition system: the software is written in C++ and features a high degree of portability, supporting a wide range of desktop, mobile, console, and virtual reality platforms. The software interface requires hard programming skills.
The 3D model of the virtual environment portrays Hall I on the museum's ground floor, today renamed *The Sekhmet Hall*. The scene repropose the 3D digital asset developed for the digital gallery of maquettes integrating them in the virtual space.
A diverse and parallel approach was to move to a more flexible and easier-to-use platform. The digital asset developed for recreating the Unreal Engine application was uploaded and reused within the SketchFab platform and Hubs by Mozilla. Hubs is a platform for creating an immersive social virtual environment (SVE) online [Hagler et al. 2022; Li et al. 2021]. It is a tool for communicating and collaborating online and allows you to connect with people and use resources available on the Internet for creating digital environments. Spoke allows to use 2D and 3D content from across the web, using data from platforms like Sketchfab and composes a virtual collection into a custom scene. 3D objects from the SketchFab gallery of the British Museum were used to replace the Sekhmet statues (figs. 10, 11).

Conclusions

The paper addresses the multiple uses of digital assets, digitalized, transformed, and reused for different dissemination purposes. The diverse storytelling approach addresses various technologies and tools related to the additional narrative opportunities the case study offers.
The workflow pipeline shows how it is possible to start with a unique collected and digitized digital asset generating multiple visualization and fruition solutions.
Transforming data means generating new and diverse digital assets affecting resolution and

metadata storage data quality. The tools and software cover various technologies researchers and non-specialist users use. Different solutions require different file formats.
The workflow proposed can be useful for cultural institutions, museums, and the heritage sector, defining a practical and comprehensive digital curation approach to their collections.

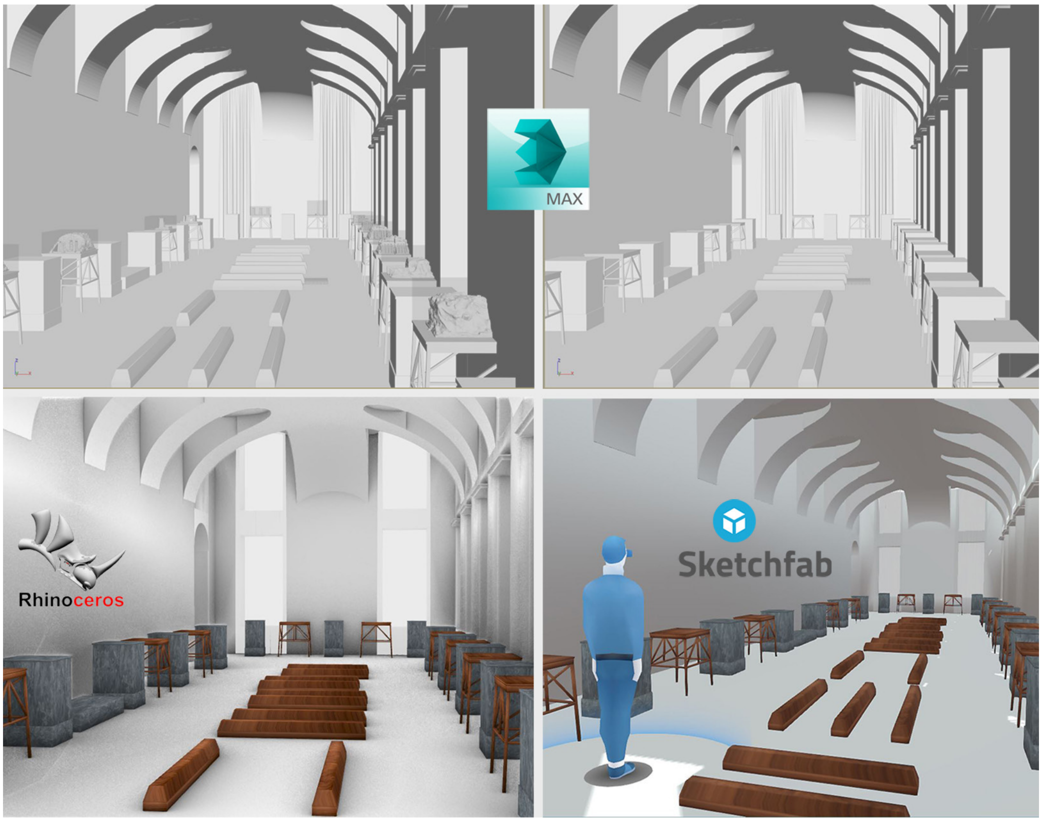


Fig. 10. The 3D environment developed for the Unreal Engine application and reused for the Spoke by Mozilla Hubs application. Post-processing phases. The scene was separated by 3D models (3DsMax), then was textured (Rhinoceros). Finally, the scene was uploaded in Sketchfab to be enriched by models using Spoke. Image by the author.



Fig. 11. Mozilla Hubs environment using the 3D assets uploaded on SketchFab. User interface of Spoke by Mozilla to enrich the scene. Image by the author.

Notes

[1] <https://www.go-fair.org/fair-principles/>

[2] The digital asset was developed during the 'B.A.C.K. TO T.H.E. F.U.T.U.RE. - BIM Acquisition as Cultural Key TO Transfer Heritage of ancient Egypt For many Uses To many Users Replayed' funded project. It was an international and interdisciplinary collaboration with the Fondazione Museo delle Antichità Egizie in Turin. Scientific coordinator: Professor Massimiliano Lo Turco, Department of Architecture and Design DAD, Politecnico di Torino.

[3] <https://sketchfab.com/backtothefuture/models>

[4] <https://3dhop.net/>

[5] <https://osiris.itabc.cnr.it/aton/>

[6] <https://hubs.mozilla.com/>

[7] <https://researchspace.org/>

[8] <https://www.europeana.eu/it>

[9] <https://researchspace.org/>

[10] MeshLab is an open-source, portable, and extensible system for processing and editing unstructured 3D triangular meshes. It provides tools for editing, cleaning, healing, inspecting, rendering, and remeshing.

[11] <https://github.com/backto-thefuture/backto-thefuture.github.io>

[12] <https://github.com/Croisened/SketchFabShowAndHide>

[13] <https://umap.openstreetmap.fr/it/>

[14] The Met 360 project. <https://www.metmuseum.org/art/online-features/met-360-project>

[15] <https://artsandculture.google.com/partner/solomon-r-guggenheim-museum>

[16] <https://www.louvre.fr/en/online-tours>

[17] <https://www.virtualuffizi.com/map-%26-virtual-tour.html>

[18] <https://www.tate.org.uk/whats-on/tate-modern/modigliani/modigliani-vr-ochre-atelier>

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